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Safety in Combat Sports: Is Boxing Safer?

Aaron Baum
abaum1@murraystate.edu

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Safety in Combat Sports: Is boxing safer?

By
Aaron Baum

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requirements for the
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Abstract

Combat sports are widely regarded as one of the most dangerous sports or activities an athlete can participate in. Leading the way in terms of popularity is the sport of boxing and Mixed Martial Arts (MMA). The resounding consensus among combat sports fans and athletes is that the sport of boxing is the safest option, but with the more recent discovery of Chronic traumatic encephalopathy (CTE) and the brain damage that occurs because of repeated strikes to the head, it appears that boxing is the most dangerous combat sport. The reason for my research project is to see what sport is in fact is the most dangerous and what makes it so detrimental to an athlete's health. Scientific breakthroughs and testing have been developing regarding the effects of the human brain after receiving blows to the head and concussions all together.

Keywords: Combat Sports, CTE

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Table of Contents

Abstract	i
Acknowledgements	ii
Introduction	1
The Nature of Boxing	3
The Nature of Mixed Martial Arts	5
CTE and Concussions	6
Structural Design of Boxing	9
Length of Boxing Matches vs. MMA	10
Training Differences	14
Frequency of Bouts	16
Unfair Matchups and Weight Cutting	18
The Role of The Cornermen	21
Referee Stoppages	23
Fatalities	27
Gloves	30
Should Boxing be Banned?	33
What Can be Done to Improve Safety	34
Conclusion	40
References	49

Introduction

The world of combat sports is one that is widely viewed as not only a historic sport but also a violent and dangerous one. Combat sports is defined as “A combat sport, or fighting sport, is a competitive contact sport that usually involves one-on-one combat. In many combat sports, a contestant wins by scoring more points than the opponent, disabling the opponent, or attacking the opponent in a specific or designated technique” (Jennings, 2021, p.169). The sport of boxing has been a staple sport in the world since the times of ancient Greece. In the year 688 BC boxing became an Olympic sport. Boxing became the most watched form of combat sport in the world for the entire 20th century. It was the most popular and widespread form of combat sport from ancient times until the rise in popularity of the sport of Mixed Martial Arts with the company the “UFC” leading the charge since it’s rise to popularity in the 1990’s and has gotten even bigger in terms of viewership and following over the last decade (Jennings, 2021).

Mixed Martial Arts fights typically involve grotesque and graphic injuries which at a glance seem highly dangerous and hazardous to athletes wellbeing. Boxing uses larger twelve to fourteen ounce more padded gloves which don’t yield the facial cutting and damage that the four-ounce Mixed Martial Arts gloves would typically produce. Boxing also implements shorter round system than its Mixed Martial Arts counterpart, no use of elbows, kicks or knees and especially no submissions or choke holds. The premise of this research project is to show the dangers of boxing and combat sports in general but to also focus on and elaborate on the differences between them and ultimately identify which sport is more dangerous and what we can do to make these sports safer for competitors. Casual viewers of these sports are quick to say MMA is a supremely violent and brain- dead sport in comparison to boxing. Spectators see athletes such as Muhammad Ali and Floyd Mayweather among other famous boxers and make a

connection in their mind that since they do not get hit as much that it is safer. Upon a glance they would appear to be right, but are they really? Is boxing genuinely safer? In any given MMA competition you watch, there is a high chance that you will see some very graphic injuries to the fighters that occasionally make you turn your head away from the television. Injuries such as cuts on someone's face profusely bleeding due to vicious elbows, athletes getting choked unconscious, suffering severe broken noses, broken arms and hands, broken orbital bones (circular bone around the eye) and recently the famous Conor McGregor who is Mixed Martial Arts and The UFC's biggest star of all time sustaining a compound fracture in his leg in the middle of the bout. Witnessing these graphic injuries will cause the knee jerk reaction that MMA is a "barbaric" and "violent" sport that damages its athletes. It is hard to disagree with this after watching (Gelber, 2016).

Contrary to popular belief there are several factors as to why boxing is potentially the more dangerous combat sport out of the two. Science deems brain and head injuries resulting from concussions as the most detrimental type of injury for long term health. With the recent discovery of CTE from repeated head trauma and how it affects your brain years later even after a fighter's career is over, studies show that MMA leads combat sports in the least amount of developed brain damage in combat sports that involve striking. Striking being the use of limbs (arms and legs) to inflict damage on an opponent via punches, kicks, and elbows. This project was designed to compare the two most popular forms of combat sport and analyze data and subjective reasoning to identify which is the most dangerous, with the goal being making the sport safer for competitors moving forward. The objective is to have the public collectively understand the dangers of combat sport to reconsider current safety measures and make the sports of boxing and combat sports safer for participants, for not only their time in the ring, but

also years after their career comes to an end. Studies show that the types of injuries in MMA are “superficial”. Meaning that they only affect the skin or body parts that will heal and not affect the athletes' long-term health. An example of this is scar tissue on someone's face or a broken hand or a cut on an athlete's eyelid. These are common types of MMA injuries; however, they are very easy ailments to repair. MMA athletes suffer these types of injuries on a regular basis with little to no bearing on their career or long-term health and wellbeing. Boxing participants suffer not only those same types of common injuries, but on top of that the nature of boxing also yields excessive amounts of concussions, CTE, brain hemorrhages and even death can occur because of these forms of brain and central nervous system traumas.

The Nature of Boxing

Boxing has been a sport for a very long time. The first recorded boxing match was recorded in the year 1681 (Heatley & Welch, 1997). It is a sport where two combatants enter a roped off square or sometimes circular “ring” and partake in hand-to-hand combat. Boxing only utilizes the athletes' arms and fists to inflict damage on their opponent via punches. One of the major reasons that boxing tops the lists of head trauma and brain damage is the simple nature of it, and where the legal “strike zone” is. Athletes are only allowed to strike above the belt and on the frontal side of the opponent. Meaning there are only two possible surfaces that a boxer can aim their punches for, the body and head. Since there are only being two places you are allowed to throw punches, the percentage of strikes to the head is significantly higher than other combat sports that utilize other non-punching disciplines. Another massive reason as to why boxing is a seriously dangerous activity is the output by the fighters. A fighter’s output is defined as the collective amount and frequency at which a fighter throws strikes. According to statisticians, in a twelve round boxing match, an average of seven hundred and twenty punches are thrown per

fighter (Lee & McGill, 2014). That is around 60 punches per round. This staggering number of punches thrown is a major contributor to the high percentage of head trauma in boxing.

Obviously, a boxer is not going to land 100% of punches thrown. A conservative average percentage of punches landed in a boxing match sits at around 50% (Lee & McGill, 2014). If you take this number and divide it by two (for the only two areas punches can be thrown at) you would get a number of one hundred and eighty significant head strikes landed over the course of a twelve-round fight.

The reason this number is conservative is that boxers target the head of their opponent more than anywhere else on the body so the number of punches thrown at the body will not be as significant. Withstanding on average one hundred and eighty blows to the head is a truly staggering number. This also does not consider the punches taken in training camps or in sparring which is where much of the cumulative brain damage takes place (Green & Tator, 2017). On average a professional boxer fights three times a year, over the course of five years they will withstand two thousand and seven hundred significant head strikes just from the sanctioned competition alone, not counting training which is year-round (McCrorry et al., 2008). Most boxers have long careers spanning well over a decade on average and step into the ring around forty times in their career. Experts believe that over the course of a boxer's entire career they may withstand thirty thousand to fifty thousand head strikes by the time they retire (McCrorry et al., 2008). The number of strikes to the head leads to concussions both acute and chronic. Acute and chronic concussions yield major detrimental effects to an athlete's brain function as well as quality of life post competing.

The Nature of Mixed Martial Arts

The sport of MMA is in fact relatively new. In the grand scheme of combat sports. The Ultimate Fighting Championship or UFC is the premier company for Mixed Martial Arts athletes. It was the first organization to develop what we know as Mixed Martial Arts today. The UFC is the most popular promotional company for the sport of Mixed Martial Arts. UFC 1, the first live sanctioned Mixed Martial Arts competition was held in 1993 and was promoted to find the best and most effective form of fighting technique and combat disciplines (Jennings, 2021). Instead of a square ring with ropes around the perimeter like in boxing, the UFC implemented an eight-sided cage with chain-link fencing around the perimeter of the octagon, which is still used today. Mixed Martial Arts is often referred to as “Cage Fighting” for this reason.

The term “Mixed Martial Arts” was thought of to be just that, a mixture of all known forms of martial arts and combat techniques to see which was the most effective in a fight. In the early days of the UFC no athletes were training in multiple combat disciplines, as time went on the sport evolved and to become a successful athlete, you must have a well-rounded base in multiple forms of combat sport. In the modern Mixed Martial Arts landscape, it takes a blend of multiple combat sports that have been around for hundreds of years, boxing included. MMA utilizes disciplines in wrestling, kickboxing, grappling, karate, Brazilian Jiu Jitsu, Muay Thai, Capoeira and of course boxing (Jennings, 2021).

Unlike in boxing, athletes have pretty much the entire body to aim attacks at excluding behind the neck and genitals and eyes. With this wide array of targets to aim for, the percentage of strikes to the head is naturally going to be significantly lower than boxing. A good example of this is the utilization of leg kicks, a highly common tactic in Mixed Martial Arts is done by kicking the legs and body of your opponent. Body shots via kicks and punches in an MMA

match are significantly higher than shots to the head on average (Jennings, 2021). Not only are the strikes dispersed over the entire body reducing brain trauma, but an element that boxing does not have are the disciplines wrestling and Jiu Jitsu. These two combat disciplines involve no striking at all and just focus on ground-based wrestling maneuvers to find dominant positions within the octagon. The aspect of ground techniques takes up a large amount of time during an MMA match. A lot of minutes are spent on the ground grappling and wrestling for position. Wrestling and Jiu Jitsu are some MMA fighter's specialties where they can spend more than ninety percent of the match on the ground. This time spent on the ground is also time spent not receiving blows to the head (Jennings, 2021).

The UFC average for strikes landed per minute is around four strikes, either punches or kicks and not all to the head but also to the body or legs. An MMA fighter may only take a few significant strikes to the head over the course of a standard five-minute round (Jennings, 2021). Based on the data, just the black and white number of strikes thrown and landed regarding both sports, it is clear that MMA athletes take a lot less head damage in bouts. MMA training camps also focus a lot on drill work and grappling training with a moderate emphasis on live sparring thus reducing the number of head strikes an athlete takes even more over the course of their career (Gelber, 2016). Based on data gathered since its inception, an average MMA athlete fights around twice a year, with the same year-round training schedule as boxing, however, the reduced number of head strikes taken in training is far more favorable for the athletes than in boxing over the course of a career.

Chronic Traumatic Encephalopathy & Concussions

When looking at injuries and damage taken in professional sports and Combat Sports specifically. Concussions and chronic traumatic encephalopathy (CTE) are by far the most

significant and dangerous injuries athletes can possibly withstand. CTE is a progressive brain condition that is thought to be caused by repeated blows to the head and repeated episodes of concussions. (McCrea & Nelson, 2014) It is particularly associated with high impact contact sports, such as boxing or American football. (Budson et al., 2018). The nature of fighting and Combat Sports yields an unbelievable amount of damage to the brain, the head, face and of course the spinal cord in the central nervous system. The number of head strikes an athlete receives directly correlates to the percentage of chance that they either get concussions or develop CTE later in life (Budson et al., 2018).

With the discovery of CTE in 2002, it has been on the forefront of medical advancement and is the focus of every contact sport since its discovery. CTE was first observed in the year 1928 when boxers and doctors referred to it as “Punch Drunk Syndrome”. It was thought to be a minor side effect and was dismissed from being a disease that would potentially jeopardize long term brain function and athlete health by medical professionals at that time. It was observed frequently in boxing gyms when athletes would have loss of balance, slurred speech, mood swings and headaches (Budson et al., 2018). CTE has been extensively studied since its scientific discovery in 2002 by Dr. Bennett Omalu. His discovery transcended the sports world and was immediately viewed as the most important disease to combat to ensure athlete safety in contact sports. Scans of both current and former athletes' brains and nervous systems from all sports were used to collect data about brain health and deterioration and were used to determine patterns as to the causation of CTE (Elleberg et al., 2019). The sports with the highest frequencies of found CTE were American football and boxing. CTE typically develops towards the end of a boxer's career due to the cumulative amount of head strikes received over the course of their life. The brain degeneration is associated with common symptoms of CTE including

memory loss, confusion, impaired judgment, impulse control problems, aggression, depression, suicidality, parkinsonism, and eventually progressive dementia (Elleberg et al., 2019).

Looking back, it is believed that Muhammad Ali, highly regarded as the greatest boxer to have ever competed, developed Parkinson's due to undiagnosed CTE from his years competing in boxing. During the time at which Muhammad Ali was competing, CTE was not discovered yet and the study of brain trauma and concussions was not as advanced as it is today with the advancement of imagery technology. There have been several famous or rather infamous cases of CTE resulting in death over the years. Professional WWE wrestlers, American football players and boxers have committed suicide because of this horrible brain disease. Unfortunately, there is no cure for CTE once you have it. When it comes to longevity and overall brain health this must be a preventative effort to not develop CTE. Repeated concussions from trauma are proven to be the factor for developing CTE (Budson et al., 2018).

Concussions are a phenomenon that occurs when an impact to the head causes the brain to move inside of the skull cavity and compress into the inside of the skull. Once you receive one concussion, it becomes easier and requires less impact to suffer another. Repeated concussions are the direct cause of CTE (Elleberg et al., 2019). Football players withstanding helmet to helmet hits, soccer players heading a ball and of course combat sports are all at high risk of concussion. In combat sports there is no tangible way to avoid getting struck in the head. The nature of combat sports requires athletes to get punched or kicked in the head over the course of a fight. Good defensive skills and being elusive are your only defense mechanism against taking strikes, but no fighter has ever not taken a head strike in their career. Even the best defensive boxers take blows to the head in each fight. Upon the discovery of CTE and seeing such a high frequency in boxers especially, doctors and scientists came together to figure out why. Why does

boxing have such elevated levels of CTE in combat athletes (Kelly et al., 2012)? What they found was several reasons. How boxing was designed structurally, the rule set of professional boxing to the types of equipment used and how boxers train among other reasons which will be explained later. The main goal of these studies was to figure out a way to make the sport of boxing safer for its participants and reduce concussions and cases of CTE to as close to zero as realistically possible.

Structural Design of Boxing

Modern boxing as we know it was developed in the year 1865 with a rules board known as the Marquess Queensberry Rules. Before the introduction of the Queensberry Rules, boxing matches were contested under what was known as the London Prize Ring rules (Heatley & Welch, 1997). One of the main differences between the London Prize Ring rules and the Queensberry rules was that in the London rules, bouts were to be fought with no padded gloves. The introduction of padded gloves was introduced in 1865 when the Queensberry Rules were devised. Another major difference between the rule sets was in the Queensberry rules, there were a set number of minutes per round and a set number of rounds for the bout to take place (Heatley & Welch, 1997). Under the Queensberry Rule set, a boxing match was to have twelve- three-minute rounds with a minute of rest in-between the rounds for the athletes to rest. If an opponent is knocked down and fails to regain back to their feet within a ten second count from the referee, the fight is declared over according to the Queensberry rules. These are still the rules that we see professional boxing commissions use today. (Heatley & Welch, 1997).

According to experts and historians these rule changes can be directly blamed for why boxing yields such high CTE rates among its athletes. From the introduction of padded gloves which make the fights last longer, to the length of the fight itself and the 10-second standing

count rule, the combination of these rule changes along with the violent nature of combat sport itself and boxing is a perfect recipe for athletes to receive numerous concussions very rapidly. Being made in the mid 1800's, with limited knowledge combined with the lack of technology brain trauma and Chronic traumatic encephalopathy were not thought of and as a result, accidentally led the sport of boxing to becoming a much more dangerous activity than it needed to be (Kelly et al., 2012).

Length of Boxing Matches vs. MMA

The sheer length of boxing matches is a major proponent of high frequency concussions. A standard professional boxing match has 12 rounds with each round being 3 minutes in length, with 1 minute rest in between rounds for fighters to recover and catch their breath. This totals a thirty-six-minute bout. Boxing experts and combat sports historians passionately believe that this is just simply too long for a fight to last (Cantu, 2014). Over the course of a match, high output explosive boxers such as Manny Pacquiao can throw upwards of a thousand punches at their opponents during the course of the thirty-six-minute bout. This hyper frequency is the exact thing that has been known to cause CTE. When athletes receive concussions and then experience more head trauma whilst already having a concussion result in brain swelling, hemorrhaging, the development of CTE and even death can occur as a result (Kelly et al., 2012).

One thing that not a lot of people tend to think about is that the brain can swell just like any other body part when it undergoes high levels of impact such as a punch. If a boxer were to get hit with a clean shot to the head, the force of the punch would snap the athletes head back and their brain would compress against the inside of the skull due to the high G force from the punch. Once this high impact mechanism takes place, the brain begins to swell inside of the head cavity. This is like when you bite your tongue, it begins to swell which makes you accidentally

bite it more often because it is bigger than normal from the swelling. Once your brain swells and expands, it becomes significantly easier for your brain to hit the inside of the skull due to the lack of room from the swelling.

Now imagine a fighter lands a combination of punches which is a common technique used in boxing, the opponent will sustain sometimes in upwards of ten head blows if the boxer is throwing what is called a “flurry”. These flurries can happen sometimes within two to three seconds. Ten significant head strikes and flurries in a matter of seconds frequently taking place over the course of a thirty-six-minute fight causes extreme levels of swelling inside of the skull (Kelly et al., 2012). Experts strongly believe that boxing matches should last half of the time that they currently do to not only make the sport easier to watch from an entertainment standpoint, but more importantly, make the fighter have less time to take unnecessary blows to the head. From the data, cutting the time of boxing matches in half would directly cut the number of punches thrown in half as well which would greatly reduce the number of concussions and reduce the risk of CTE in half in return.

In the infancy of MMA, there was no time limit, no gloves, and no standing ten-count similar to some of the aspects in pre-Queensberry boxing rules. It was for lack of a better term “street fighting”. The first UFC events were very violent with little in the way of rules, but it was noted that within the first year of MMA and the rise in popularity of the UFC it was apparent that significant changes needed to be made to increase fighter safety and make it a priority. A round system was introduced like boxing, and gloves were also introduced (Jennings, 2021). The UFC made sanctioned fights last three rounds with each round lasting five minutes for a total of fifteen minutes if the fight were to go the distance. In between rounds, MMA athletes are given a one-minute break (same as boxing) to recover.

The shorter duration of bouts in combination with the nature of the sport itself makes head strikes occur less frequently. With potentially only fifteen minutes of fight time, the techniques of body and leg kicks, the disciplines of wrestling, grappling, jiu jitsu and other ground related techniques such as submissions make strikes to the head (especially rapidly repeated ones) far more unlikely. The structure of MMA with the majority of techniques being non striking based makes it a much safer form of combat sport in regard to obtaining concussions and developing the brain disease known as CTE.

A technique that is often forgotten about when talking about MMA and combat sports is the technique known as submissions. Submissions are primarily ground based movements which do not involve striking and are more centered around wrestling (Walder, 2008). The first appearance of submissions was from a family in Brazil who developed a form of wrestling in which certain holds and maneuvers can render an opponent helpless and force them to “tap out” thus ending the match. Brazilian Jiu Jitsu (BJJ) is defined as a martial art and combat sport based on ground fighting and submission holds. BJJ as its commonly referred to as, focuses on the skill of taking an opponent to the ground, controlling one's opponent, gaining a dominant position, and using several techniques to force them into submission via joint locks or chokeholds.

BJJ was quickly recognized and regarded as the most effective ground-based discipline very quickly into its exposure to the world of combat sports. Submissions made their way into the UFC early on and have been evolving ever since. The style was known as BJJ and was unknown to the world of combat outside of the country of Brazil until it was showcased in the UFC. There are several types of basic submissions that can be applied in a MMA Match. Chokeholds, arm locks and leg locks are the three basic building blocks of submissions in the sport of Mixed Martial Arts each with their own unique series of techniques. Since the inception

of BJJ tournaments and world championships have been dedicated to this discipline and the rise in popularity of BJJ has only increased since coming to the United States, Jiu Jitsu gyms have caught on like wildfire in the combat sports community due to the proven effectiveness (Walder, 2008).

To be a well-rounded Mixed Martial Arts fighter, you must be highly trained in the discipline of Brazilian Jiu Jitsu and wrestling techniques (Jennings, 2021). If you do not have a background in these techniques, a high trained Brazilian Jiu Jitsu practitioner can get an opponent to the ground and force them to submit and stop the fight with relative ease. With each member of the UFC roster needing to have a very solid foundation in these disciplines, fights often find their way to the ground where a significant percentage of those fifteen minutes are consumed. With each minute that is spent jockeying for position on the ground it is another minute spent not taking high impact punches resulting in concussions.

Doctors and experts come to the same conclusion that it is not taking one big punch that is the issue for fighters, it is taking a high number of repeated strikes in a brief period. Every punch will add up and the cumulative number of strikes taken after years and in some athlete's cases, decades, is the difference between developing CTE and not. With the UFC gaining popularity and becoming the most watched combat sport on the market today, fans wanted to have higher stakes for main event and championship fights. A standard non championship fight can last a total of fifteen minutes, but at UFC 21, MMA fans were introduced to the five five-minute round main event (Jennings, 2021). A possible twenty-five-minute bout for the grand finale of the night. This timing system is still being used today in the UFC. Even with this lengthened bout, it is still eleven minutes shorter than a standard boxing match. With the techniques used on the ground, and targeting other body parts as well as the fatigue factor, most

main event fights tend to not make it to the end of the fifth round and in rare the instances that they do, both athletes are typically far too fatigued to have an output that would yield a high amount of volume that would result in concussions and brain damage for athletes (Jennings, 2021).

Training Differences

Doctors agree that most brain related injuries when it comes to combat sports occur during training in the gym as opposed to the actual sanctioned fight itself. MMA athletes are at a distinct undeniable advantage when it comes to this. MMA competitors are forced to divide up their training time to incorporate multiple disciplines of combat such as the previously mentioned Jiu Jitsu for example. Having to spread your training time into different fighting techniques results in MMA fighters taking less head strikes in training due to striking not being the focus. Based on my research it seems that the typical MMA athlete on average only focuses on striking around ten to fifteen percent of the time during a training camp with the rest being divided up between ground techniques and physical fitness.

Boxers on the other hand (due to the nature and rules of their sport) are only able to work on striking since there is no way for a fight to make its way to the ground via wrestling. One hundred percent of a boxer's training camp is spent refining striking techniques and sparring other opponents. Sparring is a training technique that mimics a real fight and simulates live action combat (Sondhi & Thompson, 2011). In sparring, the athlete is to participate in a simulation fight to apply the techniques learned and put them into practice against a live opponent. If a boxer is not hitting a stationary inanimate heavy bag to work on technique, they are going to be participating in some form of sparring (Sondhi & Thompson, 2011). Even training in a controlled environment such as their team's gym, fighters are still subjected to

taking blows in these simulated bouts. In a lot of boxers training camps, sparring typically exceeds the standard twelve round period for conditioning purposes. The thought process comes from the “batting donut” theory. The way of thinking being, if you can perform and get used to a bout that is longer than anything you will face in an actual match, you will be more prepared for the shorter time and thus be more conditioned and effective in your abilities (Sondhi & Thompson, 2011). These (sometimes fifty plus minute) sparring sessions happen quite frequently, sometimes as often as three to four times a week in the months leading up to a fight. Neurological specialists believe that these frequent and lengthy sparring sessions are what develop CTE, not the fights themselves. With the data supporting the fact that most injuries occur in training, it is obvious that these live sparring sessions are indeed to blame for a substantial portion of these traumatic brain injuries and concussions that occur during a boxer’s career.

MMA training camps are far more focused on technique-based drill work with a major focus of energy being put on physical conditioning and strength training. One of the most popular and decorated MMA athletes, Conor McGregor, bases his training camps with a high emphasis in physical fitness with the least amount of his focus being put in sparring (Kavanagh & Dollery, 2017). The multiple weight division World Champion in the UFC believes at this point in his career, that he has developed his skill set enough to the point that he would rather utilize his time in strength training, cardio conditioning and flexibility whilst sharpening his tools of combat throughout the course of his training camp (Kavanagh & Dollery, 2017). From my research, Conor McGregor and his team had put forth a major priority on longevity with a large focus on not taking unnecessary blows which would shorten his career. This way of thinking is commonplace in the MMA and UFC communities. Each fighter's main goal in this modern era of

the fight game seems to be prolonging their career and maximizing the number of paychecks they are able receive while taking as little damage as possible. MMA athletes are very cognoscente of health and wellbeing to increase their longevity in the sport. It is understood that taking damage in training does MMA athletes no favors and is a detriment that must be avoided (Gelber, 2016).

Frequency of Bouts

MMA competitors on average fight a significant amount less than a boxer would over the course of their athletic career. Some variables that would potentially affect the frequency of an MMA fighter's activity are how long injuries would take to heal, opponent scheduling issues or even how other fights in their weight division are affecting the rankings of that fighter. With, UFC fighters partake in actual live sanctioned bouts on average 1.5 times per calendar year. Effectively half of what the average boxer would undertake during a year. Some very high-profile MMA competitors go so far as to fight only once per year such as the Conor McGregor.

The frequency of fights during a fighter's career parallels how their training camp schedule would be. A typical training camp for a fighter in any combat sport is usually synonymous with being a twelve-week bootcamp (Heatley & Welch, 1997). The first three to five weeks of the twelve-week bootcamp is dedicated to getting the athlete back into fighting shape via strength and conditioning with little focus on performing combat skills. The remainder of the training camp is used to fine tune the athlete and make sure the techniques and skills they possess are perfected (Sondhi & Thompson, 2011). A professional boxer fights on average three times per year which is effectively double of what a UFC rostered fighter would, with some exceptions for the utmost popular. Fighting three times per year and undergoing a three- month bootcamp leads the average boxer to being in the gym and exchanging blows for nine months per

year, whereas Mixed Martial artists on average are in the gym for training camp for four and a half months a year. The rest of the time is dedicated to staying in shape and maintaining muscle tone and cardiovascular fitness.

Floyd Mayweather is renowned as one of the greatest professional boxers to ever lace up the leather. His illustrious career sits at a staggering fifty wins and zero losses. Floyd has stepped inside the boxing ring professionally fifty times and numerous more times for his amateur career. He won his first amateur championship in 1993 and began his professional career in 1996. He was an active professional boxer from 1996- 2017. Floyd Mayweather's undefeated record stands as one of the best athletic records ever held and cements himself at the top of the boxing hierarchy.

However, in comparison of one of the one of all-time great UFC Champions, Khabib Nurmagomedov (who is also an undefeated champion) with a record of twenty-nine wins and zero losses, the twenty-one-fight differential between Floyd and Khabib is immense. Twenty-nine total fights are in the upper level in terms of frequency for a MMA career. His fighting style is primarily wrestling based, over ninety percent of his fights are spent on the ground in wrestling and grappling exchanges with has led to his longevity and minimized the neurological damage he has taken.

Taking these two champions and comparing them even though they participate in two different combat sports, is a very fair assessment to understand the differences in these two sports. Nurmagomedov had underwent twenty-one fewer training camps than Floyd Mayweather over the course of his career which only helps his overall cognitive and brain health since he has not received the blows to the head that a boxer would've. The frequency of bouts and competition needs to be managed to prioritize the health, safety, and longevity of the fighter, as

opposed to climbing the rankings as fast as possible according to experts and doctors who are studying brain trauma (Shurley & Todd, 2012).

Unfair Matchups and Weight Cutting

The sport of boxing is often synonymous with corruption and politics. Boxing companies or “promotions” which what they are referred to in the boxing industry are always looking for a new up and coming fighter to promote and make popular (Hauser, 2005). A highly touted fighter can sign a contract to fight under a certain promotion and be groomed to be the next big star from early in their career. What this often means is the promoted fighter will be given easier fights than someone who is not as popular early in their career. The boxing promotion understands that their fighter is highly skilled and has all the potential to be a top ranked boxer.

In the case of the aforementioned Floyd Mayweather (who has fifty professional fights) was given by the boxing organization unranked opponents for a majority of his career. Boxing organizations want to “pad the stats” of their promoted fighter so that they are perceived to be potentially better than they actually are so fans can follow the journey. If a boxer has more than five losses in their career they are often viewed as being out of contention of a championship and deemed to be an average boxer by fight fans. Keeping the promoted fighters record as perfect as possible is what the promotion attempts to accomplish by giving the popular fighter easier less skilled opponents (Hauser, 2005).

This manipulation can often have extremely dangerous effects on a boxer's health. With the opponent being notably less skilled, the boxer who is being pushed by the promotional company usually will win the fight with relative ease. These lesser skilled fighters often have a tough time keeping up with and defending themselves effectively against the more skilled boxer. This distinct difference in skill is incredibly unsafe and can result in the less skilled fighter being

struck at exceedingly high volumes. A relatable example of this would be a hypothetical scenario where a trained fighter was to get into an altercation with someone who has no combat training. The obvious ending would be that the trained fighter would severely injure and damage the untrained individual, this is an exaggerated form of what is happening in this style of fight promotion. Lesser skilled boxers are being put in dangerous situations for the sake of fighter promotion.

In the sport of MMA, the UFC only schedules matches based on factors such as skill, experience, combat record and division ranking. The UFC would not match a fighter who has a record of fifteen wins and one loss against a fighter who has a record of seven wins and nine losses. Even at the highest levels of combat sport, the skill discrepancy between the champion and a fighter who is ranked number five can be drastic.

Cutting weight is a phenomenon where a combat sports athlete will dehydrate and starve themselves to “make weight” for their fight. The reason combat sports athletes do this is to give them a size advantage over their opponent (Evans, 2013). All sanctioned bouts are fought at a specific weight (usually in pounds). To be eligible to fight, you must not weigh more than the weight class limit. If a boxer signed a contract to fight at a weight of one hundred and fifty-five pounds, he must show up on weigh in day at exactly that. The reason for weight classes to exist is to try and even the playing field amongst fighters (Evans, 2013). It is viewed as an advantage for a larger man to win a fight against a smaller man. Having weight classes keeps the fighters all at similar body sizes naturally. Not only will you be the bigger fighter, but there is also a financial incentive. If a fighter were to miss the weight of the sanctioned bout and exceed the designated weight limit, he will forfeit a percentage of his purse to his opponent. Weight cutting in combat sports is a very dangerous and often overlooked aspect of the fighting industry.

To gain an advantage and be the larger fighter, boxers and MMA fighters will cut immense amounts of weight to reach a weight class that is filled with genetically smaller individuals (Evans, 2013). For example, one of boxing's most notable stars Canelo Alvarez competes at a weight class that has a one hundred- and fifty-two-pound limit. However, Canelo Alvarez walks around when not in a fight camp at around one hundred and seventy-five pounds. These weight cuts are very draining on the fighter's body. To make weight the boxer will stand in a sauna or hot tub for hours to sweat off the excess weight. This means for a boxer like Canelo Alvarez, they are sweating around twenty-three pounds of water weight to not exceed the limit. These levels of extreme dehydration are very dangerous for not only the body but also the brain. Not having enough water will put a severe strain on the boxers' kidneys, sometimes resulting in kidney failure. Over the course of history, boxers have been known to pull out of fights because they become hospitalized from kidney failure, dehydration, and exhaustion as a result from cutting too much weight (Evans, 2013). This lack of water also affects the brain. The brain has comparable properties to a sponge. When fully hydrated, the brain will be at a normal size and function properly and take up a large part of the skull cavity.

When weight cutting, the brain will shrink due to the lack of water. This brain shrinking phenomenon can yield major hazards. If the brain is smaller and not taking up the normal amount of volume in the skull cavity, there will be larger gaps between the walls of the skull and the brain. When a dehydrated fighter receives a punch to the head, the brain will crash into the inside of the skull at a much harder impact since the brain has more room to gather speed. The dangers of weight cutting have been widely documented and debated. Doctors agree that weight cutting should be banned from boxing and combat sport (Evans, 2013).

The Role of The Cornermen

The implementation of a fighters cornerman is a very important structural piece of a competitor's safety. A fighters corner usually consists of three to five trained coaches that the athlete must have a high level of trust in (Smario, 2000). A fighter must not only trust his corner for accurate training and advice, but also trust them to make tough decisions on behalf of himself. The individuals that comprise the corner are typically the fighters' coaches that have been with the athlete for years, thus they know their fighter as an athlete and competitor better than anyone else would. The cornermen for a fighter have a few main jobs during the duration of a bout. One of the secondary tasks (that is often mistaken for as the primary job) that a corner provides is giving their fighter tips on how to be more successful during the fight. Since the corner is comprised of high-level coaches, they have expert fight knowledge, and they provide a different set of eyes on what is happening during the fight and relay potential adjustments to the fighter both during the fight and in between rounds (Smario, 2000).

A MMA fighter's corners primary reason for being at the fight cage-side is for helping their fighter have the best chance to win by implementing fight adjustments and providing moral support to the athlete during the course of the fight (Kavanagh & Dollery, 2017). On the contrary, a boxer's corner's primary job is fighter safety with the secondary responsibility being making fight adjustments. The reason that these two cornermen's responsibilities are reversed is due to the way that each sports refereeing structure is laid out. We have all heard the phrase "throw in the towel." The origin of this phrase comes from the sport of boxing.

During a fight, if a cornerman sees that their athlete is taking far too much damage and is no longer in contention to win the fight, the cornerman can quite literally throw a towel into the ring thus signifying to the referee and others that they are essentially surrendering on behalf of

their fighter without their fighter's input (Smario, 2000). The cornerman can choose to throw the towel in during the round if their athlete is getting dominated, or they can choose to throw the towel into the ring in between rounds if their fighter is not responding to stimuli in the way that they would like (Smario, 2000). This practice is one that was widely used in the early days of sanctioned boxing matches in the early to mid-1900's but has since lost popularity in recent years as fighters become more outspoken about "going out on their shield". When a fighter wants to "go out on their shield", it means in fighter terms that they want to continue battling until either they get knocked out, or the time stops (Cantu, 2014).

Boxers and MMA athletes carry so much pride with them that it often overrides any logical way of thinking, especially during a live fight. To a combat sports athlete, having your team throw in the towel is viewed as embarrassing for them. A combat athlete would almost always view this in the most negative way possible, they believe that you were getting beaten so badly that your own team gives up on you. Which is not the truth of the situation, but fighters typically carry an ego that clouds logic and judgment for their wellbeing.

Cornermen are aware of this aspect and mentality of fighters, and it is their primary responsibility to be the adult in the room and do what is best for their athlete's health and safety. The corner and coaches job first and foremost is to be responsible and get your fighter home in one piece without taking unnecessary damage (Smario, 2000). What we are seeing trend in the more modern era of boxing is cornermen throwing in the towel less and less, thus making boxers have to withstand abundant and powerful shots to the head while being essentially defenseless due to reduced motor function capability for the remainder of the fight. This lack of responsibility from the corner often results in a high rate of boxers being put into comas,

becoming paralyzed, losing their eyesight and even resulting in fatalities either in the ring or in the hospital after the bout is over due to overwhelming brain trauma (Cantu, 2014).

Referee Stoppages

The structure of all sanctioned combat sports requires the use of a built-in safety measure known as the referee. A referee is a highly trained medical professional that stands inside the ring or octagon and provides supervision and enforces the rules of each specific sport during the fight (Bradley, 2014). The primary objective of the referee is to monitor athlete safety and make sure the competitors are not in unnecessary danger or risk of injury and enforce the rules and guidelines of that specific sport (Bradley, 2014). Not only are the established rule systems in boxing and MMA very different, but how referees are supposed to monitor the fights and supervise them different as well.

In the sport of boxing, the referee is usually there to separate the boxers from one another when they are what is known as a clinch. A clinch is performed when both boxers are very close to each other and wrap their arms around one another to minimize potential for close range shots either to the head or body. Clinching is a common tactic used by every boxer and is even a skill that must be developed. The clinch is typically initiated when one boxer has their back against the corner or ropes to gather their breath, weather a storm of punches or is not in an ideal situation and wants separation via referee intervention. When the boxing referee sees the competitors engaged in a clinch, he will step in, separate them a few feet from each other and then tell both parties to resume from a normal boxing stance and approach (Bradley, 2014). It is used to jump start the action back up because the clinch can severely slow down the pace of a boxing match and be viewed as boring by spectators.

This intervention is what you will most frequently see from boxing referees during the duration of a boxing match as the clinch can happen several times a round depending on fighter fatigue or the damage a boxer is taking. Fighter safety in boxing is often not thought about in terms of the rule set and how they affect the safety of athletes. Since the inception of the Queensberry rules, very few amendments have been made, therefore making the rule set not become questioned. One rule that directly results in unnecessary damage for a boxer is the rule of the standing ten count.

The Queensberry Rules state that if a boxer is hit with a punch and falls to the floor as a result of that punch due to a brief lapse in consciousness or motor function, the referee will stand next to the downed athlete and audibly count to ten (Bradley, 2014). The counting itself is not ten actual seconds, it is more of a slower drawn-out cadence giving the boxer more time to get back up. If the boxer is in fact able to return to his feet within the ten second count, they are eligible to resume the match. According to experts and brain trauma doctors, this rule by itself is a major cause of boxing fatalities and serious neurological damage.

During a fight, a boxer can get hit with what boxers and experts call a “flash knockout”. A flash knockout occurs when an athlete receives a shot to the head that is so hard that the brain essentially shuts itself off to prevent further damage (McCrory et al., 2008). These lapses in consciousness can last for twenty seconds or more. However, some of these flash knockouts can only last less than a few seconds. Watching a boxing match, you will often see a boxer get punched in the skull, fall to the ground, and somehow return to his feet before the ten second count is over. A famous example of this occurred recently in a very high-profile boxing match between the top two heavyweights in the world. In the final round of a boxing match between knockout artist Deontay Wilder and World Champion Tyson Fury, Fury (who had dominated the

bout) was caught with a massively explosive right hand from Wilder. This type of punch is what made Deontay Wilder so well-known and highly regarded over the course of his career. Upon receiving this devastating blow right in the skull, Tyson Fury lost consciousness and fell helplessly to the canvas. The crowd (thinking the fight was over) erupted in cheers. However, during the standing ten count, Tyson Fury was somehow able to stand up and return to the fight to the disbelief of everyone watching (Hainline et al., 2019).

This level of blunt force trauma to the skull resulting in brain inactivity and loss of consciousness is one, if not the most dangerous aspect of boxing regarding brain trauma. Repeated trauma to the brain from typical non-power punches yields immense damage by themselves and are the cause of repeat concussions which is the direct cause of CTE. The knockout is the highest possible level of impact that the brain can withstand. Sometimes these flash knockouts can happen early in the fight, meaning the boxer can still potentially have thirty minutes or more of getting repeatedly concussed. Getting back up after exceeding the brains capabilities and taking more punches as well as being at risk for more flash knockouts, concussions and taking even more trauma that exceeds the threshold often results in severe brain damage and even can often result in death of the athlete (McCrory et al., 2008). This, however, is not considered to be the referee's fault as it is the standard practice for sanctioned boxing matches to implement the standing ten count rule.

On the contrary, the sport of MMA does not have a standing ten count rule. Since the fights are able to continue on the ground, if a fighter gets hit with a hard punch or kick resulting in a flash knockout, they will fall to the mat and their opponent will typically assume a position of dominance and usually look to end the fight via a technical knockout (or TKO for short) by

throwing two to three punches on the downed opponent typically within fifteen seconds of the flash knockout taking place (Castellano, 2016).

A referee can end the fight a deem it to be a technical knockout (TKO) even if the downed athlete is conscious and is blocking all punches while on the ground. If the athlete is in a position where he cannot return strikes or is curled up in a defensive posture called “guard” the referee will step in and put an end to the fight thus putting an end to the amount of unnecessary damage the fighter is about to take. A “technical knockout finish” is its own specific fight ending statistic and happens when a fighter undergoes a hard punch or series of punches and strikes, and the referee stops the fight, so the damaged fighter does not take any unnecessary trauma and the winning fighter is credited with a TKO finish in the record books (Castellano, 2016).

The in-ring announcer will say “and the winner by TKO” in the post-fight address. The referee essentially “throws in the towel” for the downed fighter. This is standard practice in the world of Mixed Martial Arts and is widely accepted and is the most common way for a fight to end. Referees also often receive praises for making good stoppages and ending the fight in a quick and concise manner. In Mixed Martial Arts, a regular knockout can also take place. When a fighter takes a big strike and falls to the ground losing consciousness for longer than what a flash knockout would be, the referee can make a call based on judgment that the downed fighter has no possibility to continue or put himself in guard, and the referee stops the fight before any more strikes can be thrown and landed. (Castellano, 2016)

This safety measure built into MMA has saved a lot of fighters from withstanding immense amounts of damage and costly brain trauma. Similarly, in the UFC, a cornerman can also throw in the towel meaning that athletes have several more avenues of safety than a boxer

would typically have. A Mixed Martial Arts cornerman very rarely if ever, will throw the towel in due to the encompassing nature of the referee stoppage protocols.

Fatalities

The idea of fatality resulting from hand-to-hand combat is one that has been present since the idea of conflict in the beginning of mankind. Two unarmed combatants fighting each other to the death for territory, protection, sustenance, items, and shelter is a primal philosophy that has been outdated in humans in recent centuries. The subconscious longing for primal conflict is what makes combat sports appeal to the public whether if they know it or not. It is an animalistic ideology, and it is wired into the homosapien gene.

With the invention of unarmed combat not for survival, but for sport, is one that has attracted humans since the times of ancient Greece. Men tend to favor watching combat sports over women as it relates to the hunter/ gatherer part of the human brain. The element of defending yourself and the subconscious nature to be considered an alpha male attracts men to watching and practicing Mixed Martial Arts and entering combat sports competitions (which panders to the male hormone testosterone) and is participated by men in far greater percentages than women. Fatalities from modern combat, or “combat sports” as it is referred, is something that continue to happen to this day unfortunately. On average thirteen boxers per year die in the ring because of repeated brain trauma. The aforementioned causes of brain trauma (repeated blows in a short period of time, irresponsible fighter management from coaches and corner as well as the rule set in professional boxing relating to the referee’s job are the reason deaths in combat sports continue to occur according to experts and doctors (McCrorry et al., 2008).

Although no exact figures are available, it is conservatively estimated that around two thousand boxers from both professional and amateur ranks have lost their lives in the ring or

shortly after a fight because of punches since the year 1865 when the Queensberry rules were implemented (McCrory et al., 2008). Since the year 2000, thirty-three professional boxing fatalities have been accounted for with the most recent being a Russian boxer named Arest Saakyan.

On January 7th, 2022, Arest Saakyan died as a result of repeated blows during the eighth round of a bout being held in Russia. He left the ring and died in a coma ten days later. Another boxer in recent memory being Patrick Day in the year 2019. Day an American boxer who was at the time ranked within the top ten in the world for his weight class was a highly talented boxer with a professional record of seventeen wins and five losses. Patrick Day was a twenty-seven-year-old boxer who after sustaining a barrage of punches from his opponent, laid knocked out on the canvas and was subsequently placed in a medically induced coma where he died four days later from the brain trauma he sustained in his fight.

Experts believe that if the corner of Patrick Day were to have ended the fight by throwing in the towel before the tenth round (when the fatal series of blows took place), Patrick Day would not have been placed in a coma and still be here today (Hainline et al., 2019). With the staggering number of thirteen deaths a year in the sport of boxing as a direct result of punches leading to brain trauma, boxing tops the list of all combat sports in fatalities. Medical experts say boxing related deaths come from one thing above all else, rapid, and repeated blows to an already concussed brain (McCrory et al., 2008). Mentioned earlier, the brain swells after a concussion takes place and begins filling the skull cavity placing the brain and skull under immense pressure. With the brain being swollen, the impact that is required to cause a concussion decreases with each strike of the head resulting in brain hemorrhaging. Brain hemorrhaging is the medical term for when blood vessels inside the brain rupture causing

uncontrollable bleeding within parts of the brain which often leads to death or severe loss of brain function. Brain hemorrhaging is a curable condition if it is treated quickly, not overly severe and when bleeding in the skull is controllable during medical procedure. However, in these boxing matches where athletes suffer from brain bleeding, it often goes undetected for several rounds. It is often hard to spot while observing a boxer as it can often be misdiagnosed as the boxer just being wobbled or having weak legs from fatigue. Fighter adrenaline also masks how severe the skull damage can be, but once the adrenaline subsides, a coma is usually the result. With each minute that passes and with each strike that lands, the chances of recovery and even survival significantly worsen for the athlete (Hainline et al., 2019).

Brain injuries caused by trauma such as punches compound on themselves (McCroory et al., 2008). That means each punch or strike landed on the head of an athlete that has an undetected hemorrhage or series of concussions does significantly more damage than the last one to the point in which the boxer collapses in the ring as in the case of the late Patrick Day or Arest Saakyan. The compiling nature of these brain trauma injuries would be greatly reduced if it weren't for the standing ten count allowing a brain damaged fighter to get up and continue both trauma surgeons and experts agree.

MMA does not have a flawless record either. However, there have only been seven fatalities recorded in Mixed Martial Arts history between both amateur ranks and professional fighters since its inception in the early 1990's and none of which have been in MMA's top company (The UFC). Seven deaths over the course of thirty years versus thirteen fatalities per year in boxing is an astonishing difference. The implementation of the Mixed Martial Arts rule set combined with ground disciplines and wrestling techniques, the protective nature and use of referees, no standing ten count rule, the fight ending rule of the Technical Knockout as well as

the equipment used makes the number of Mixed Martial Arts related fatalities so much lower when compared to boxing. Speculation before medical and scientific entities started research in this area, it was sometimes simply chalked up to “boxers just hit harder”.

Gloves

Most forms of combat sport require the use of some form of padded leather glove, usually filled with cotton, or another fiber (Lee & McGill, 2014). Wrestling and Jiu-Jitsu are some sports that do not require the use of gloves as there is not a striking element striking in those sports.

Gloves are used in combat sports for several reasons. One major reason is to protect the fighters' hands. In both boxing and MMA, the hands are used not only to throw punches but also to block them. In boxing, defending your head and body by way of moving your gloves in the way of the punch to deflect or absorb the energy of the blow is boxing's standard form of defense. In MMA, gloves are used in the same fashion, however they are also utilized to block and protect from opponents kicks as well as punches and elbow strikes. Although both combat sports uses of gloves are similar, the gloves themselves are vastly different, not only in size but also in how they are shaped. In the sport of boxing, the shape of the gloves resembles that of a pair of fingerless oven mittens. There is a separation built in for the thumb to go into, and the four remaining fingers reside in the same cavity with a curved shape to help the boxer be able to form a fist.

The construction of a boxing glove is simple. The inside of a boxing glove is heavily padded with a specific type of fiber padding, usually made from horsehair or sometimes stuffed with cotton fibers. The outside of the glove is typically wrapped in a tightly secured sheet of leather. The wrist cuff at the bottom of the boxing glove is traditionally only leather. The gloves tightening mechanism can be Velcro, however in professional boxing they are tightened with a

lace because the Velcro would occasionally cause abrasions or cuts in the opposing boxers face or arms due to the rough nature of Velcro. Boxers also utilize what are known as hand wraps underneath their gloves for added protection and to increase wrist rigidity to reduce to risk of sustaining a sprained wrist. The hand wraps are a long piece of two-inch-wide cotton cloth that the boxer will wrap around the wrist as well as in-between the fingers and palm for even more added knuckle support. The weight of a professional boxing glove that is used in sanctioned events is a minimum of ten ounces, with some gloves being twelve ounces (Evans, 2013).

When in comparison to MMA gloves which are four ounces, boxing gloves seem very large and highly padded, especially with the use of the hand wraps. Boxing gloves are often taped around the wrist lace to ensure that the lace will not flap around or come undone. The strike force and physics relating to the kinetic properties of boxing gloves is yet another factor in increased brain damage and CTE rates (Lee & McGill, 2014). When compared to a bare fist, a padded professional boxing glove reduces the impact force by forty percent. (Lee & McGill, 2014) This may seem like a good thing to some, however, when you understand that prolonging fights and taking high numbers of punches to the head is the most dangerous part of boxing in regard to cumulative brain trauma, having a soft, more forgiving set of gloves is the opposite of what would be needed to minimize the potential for serious brain injury and death (Lee & McGill, 2014).

A new form of boxing organization has recently been introduced within the past several years, that is the sport of bare-knuckle boxing. As the name implies, the participating athletes do not wear any form of glove but only wear wrist wraps to prevent potential wrist sprains and injuries. Since its inception, bare knuckle boxing has gained popularity due to its rawer, rougher and tumble nature. Facial lacerations, broken hands and cheek bones are very common injuries in

bare-knuckle boxing; however, scientists believe that this form of combat is remarkably safer than traditional boxing in regard to brain trauma.

But how would this be safer? Professional boxers can punch with 1700 pounds per square inch (PSI) of force (Lee & McGill, 2014). That is more than double of what an adult lions bite force registers in at. What does all this mean? Boxing experts and brain trauma doctors agree that having lighter, less padded gloves would be better for long term brain health of professional boxers. If professional boxers were to use lighter weighted less padded gloves, boxing matches would end a lot sooner because the less force absorbed by the gloves would transfer into the boxer who is being hit. The harder a boxer were to get hit, the less likely it is that they will be able to regain consciousness and be able to regain themselves back to their feet during the standing ten count. Even though that these gloves are padded and soft, they do still transfer enough power, kinetic energy, shockwave, and g-force into the opponent's brain when punches land to the head.

If the gloves were redesigned to be smaller and filled with less padding, boxers would physically not be able to withstand as many punches meaning the dangers of repeated concussions that develop CTE would drop off significantly. A boxer could hypothetically take a punch with the more padded glove that might cause a flash knockout in the first-round but didn't exert quite enough force to put him down for the ten count, resulting in that boxer returning to his feet to receive more blows when the fight could have been potentially over in the first round. A boxer who was to withstand the same punch mentioned before but rather with a less padded glove, might lose consciousness and be down for the ten count which would save him from receiving hundreds of more blows to the head. Facial lacerations and hand injuries would

increase similarly to bare-knuckle boxing, but those superficial injuries yield no bearing on long term health and cognitive brain function (Lee & McGill, 2014).

MMA gloves are unique and structurally different when compared to boxing gloves. Mixed Martial Arts gloves more closely resemble that of traditional fingerless gloves you might wear for bike riding or hiking. MMA gloves have small amounts of fibrous padding throughout them mostly being concentrated on the top of the hand. There is a space for each individual finger and thumb, as well as having an open palm area that is not covered by any material. The finger slots on MMA gloves are covered only to the first knuckle on each finger of the athlete.

The reason for MMA gloves not having the fingers covered fully like boxing gloves is because of the wrestling and Jiu Jitsu element of the sport. In those ground-based disciplines, the athlete would need to use their hands to grab your opponent and grip their wrists, ankles etc. otherwise the techniques would be useless and ineffective. The four-ounce MMA gloves were introduced in the 1990's by the Ultimate Fighting Championship and have had no changes or amendments made to them throughout the course of the sports history. Knockout as well as knockdown rates in Mixed Martial Arts are very high and MMA experts and physicists attribute that to the lighter gloves as they absorb significantly less force which means more of the energy from the punch is transferred into the opponent, knocking him out without any chance of getting up and having to take more blows (Lee & McGill, 2014).

Should Boxing be Banned?

With the recent fatalities of Arest Saakyan and Patrick Day, medical professionals have been increasing discussions for as to whether the sport of boxing should be banned. This has become such a pressing issue that the World Medical Association came on record to state that the sport of boxing should in fact be banned. This of course is met with a lot of resistance from

boxing organizations, its athletes, and fans. The ban of traditional boxing is one that been talked about for a long time and makes a resurgence whenever a serious brain injury or fatality occurs. (Cantu, 1994) The rapid improvement of scientific and medical testing and the discovery of CTE in the year 2002 has strengthened the argument for as to why boxing should be banned.

It is interesting that the discovery of CTE was immediately used as point of emphasis for American Football to develop new ways to be safer while there were no talks about banning it as a competitive sport. Instead of shutting down football (maybe because it is the biggest sport in the United States) strong efforts were made to increase player safety. New rules prohibiting the incredibly dangerous “helmet to helmet hit” were implemented as well and serious design changes were made to the helmets themselves to absorb more of the impact resulting in a tackle. Fundamental coaching points were reevaluated, changing tackling techniques and new drills were devised to teach athletes the safest way to make tackles. Boxing historians and experts feel that this is the approach that should be taken and applied to the sport of boxing. For boxing to trend in the direction of safety, the concept of safety needs to be a major priority. Implementation of rule changes, remodeling of the equipment and gloves as well as revamping training are things that need to be adjusted to prevent further deaths and keep the sport of boxing alive without fear of getting banned (Cantu, 1994).

What Can Be Done to Improve Safety?

Changing the fundamental rules and putting effort into safety is a sure-fire way to reduce serious injury in boxing. Boxing experts agree that just like with any dangerous activity, knowledge and informing athletes of the dangers is the best first step that boxing commissions can take to jumpstart the trend of safety (Cantu, 1994). With each passing year, new data is found which supports the idea that boxing is in fact the most dangerous combat sport. Making

this a widespread issue and proactively using the newly found data to make this public knowledge would increase the development of new safety protocols. Throughout this research project, there have been many topics and ideas that directly go against and contradict prioritizing the long-term safety of the sport of boxing and place boxing participants in unneeded danger.

To create a safer environment for boxing, certain changes need to be made sooner than later. Rules such as the standing ten count, which gives the damaged boxer far too long to regain their bearings and continue with the fight need to be rescinded. Boxing analysts state that this rule would need to be amended by either removing the ten count completely from competition or shortening the count to five or six seconds (Cantu, 1994). With a shorter time limit on the standing count being implemented, it would help assure that if a boxer were to get up after a knockdown, the boxer did not receive a detrimental enough blow to the head and in turn, the athlete who would've gotten up at the nine second mark after taking a more vicious blow would no longer be eligible and not take any more damage.

Another rule change that should be implemented is in regard to the jurisdiction of the referee. If a referee in boxing were to be able to end the fight based on a judgement call (like how MMA referees implement the Technical Knockout) prolonged bouts resulting in extreme levels of trauma would be far less likely to occur. Referee intervention in boxing must be implemented more so than it already is to ensure fighter safety (Cantu, 1994). If a referee were to witness an athlete getting dominated while still withstanding numerous undefended shots to the head, rather than waiting for the athlete to collapse, stepping in and ending the fight with the Technical Knockout clause, would greatly benefit the damaged combatant.

Changes to the sport of boxing also need to be looked at and implemented within the aspect of training and training camps. Pushing cutting edge data about brain trauma and CTE while making it a point of emphasis would force coaches and trainers to look at the way their athlete is being trained very differently. Boxing coaches are notoriously old school in their way of thinking when it comes to boxing training. A high percentage of boxing coaches think that the more their athlete gets hit in training, it will toughen up the fighter and make it harder for them to get knocked out. Data supports that this is directly the opposite way of thinking that needs to be implemented (Cantu, 2014). Instead of putting a boxer through hundreds of hours of live sparring, more focus should be placed on fighter longevity and not withstanding unnecessary blows to the head. The more shots to the head a fighter take over their career will not make them any more invulnerable to punches when it comes down to the actual fight, instead it will actually have the opposite effect, making the number of punches they are able to withstand significantly less (Cantu, 1994).

In the MMA community this phenomenon is called “having a glass jaw”. This was widely accepted decades ago and the science behind it was assumed to be correct but not proven till the discovery of CTE and more testing had begun to take place. The general concept of a fighter losing his or her “jaw” over their career goes back to the concept of brain swelling and skull damage. The brain acts similarly to other organs that undergo repeated trauma, it will swell putting immense pressure on itself and then as it is healing will develop scar tissue. Scar tissue buildup occurs when repeated trauma to an area causes the organ tissue to repair itself with a thicker, more durable, and less pliable tissue (Budson et al., 2018). This less pliable tissue when developed in the brain begins to take up more space inside of the skull due to scar tissue being

larger in volume than normal brain tissues. With less room in the brain from the increased volume, the brain will come in contact with the inside of the skull easier and more frequently. This results in a fighter not being able to withstand the hard impacts that they used to take earlier in their boxing career (Budson et al., 2018).

The next focus of improvement needs to come in the form of redeveloping the boxing glove itself. The current boxing gloves used in professional boxing are far too soft. Boxing commissions need to analyze the data and understand that boxers are taking far too many punches and make the sanctioned gloves less padded. Simply reducing the glove weight from ten or twelve ounces eight or even six ounces will drastically lower the average length of bouts and lessen the number of punches a boxer takes (Cantu, 1994).

On the topic of the length of boxing matches, boxing experts believe that reducing the number of rounds a boxing match will help the rate at which boxers are developing CTE and concussions. Lowering the number of rounds from twelve to eight would lessen the time that a boxer is taking punches for. Towards the end of a boxing match or Mixed Martial Arts fight athletes are often incredibly fatigued. When an athlete reaches that level of exhaustion, it becomes difficult to defend yourself properly and effectively. Not having the energy to hold your hands up to block oncoming punches is another main reason doctors are in favor of shortening boxing matches from thirty-six minutes to twenty-four (Cantu, 1994).

Shortening the number of rounds will also yield benefits in the training aspect as well. Instead of sparring to prepare for a twelve-round fight (which boxers will spar almost twenty rounds for conditioning) a boxer will only have to train for eight. Even if the fight is eight rounds long, the coaches can still push the athlete beyond the scheduled round number to somewhere around twelve live sparring rounds which decreases the number of punches a boxer takes in his

training. With these potential rule changes implemented, doctors believe that the number of fatalities will go down along with the currently staggering number of CTE development among boxers.

Another potential rule change that would benefit fighter safety is lengthening the time spent in between rounds. Fighter exhaustion as previously mentioned is a major determining factor how many punches a fighter will take over the course of the fight. It is believed that the simple amendment of adding an additional thirty-second to one minute more time to the clock in between rounds for rest. As of now, a boxer will only have one minute to catch his breath and recover physically from the previous round. If this time in between rounds was lengthened to one minute and thirty seconds or two minutes, the boxer in theory will have more energy left for when the fight gets into the later rounds. If a boxer has more energy, he will be able to move his feet more sharply and be able to raise his gloves properly and more effectively to block and deflect oncoming punches resulting in less head and brain trauma as a result.

The idea of implementing a “Knockout Limit” in boxing is one that has been proposed in recent years since the discovery and research of CTE. The knockout limit rule would in theory be a finite number for how many knockouts a boxer is allowed to withstand before their career is over and boxing license is revoked (Cantu, 1994). This rule would drastically change everything we know about boxing, and boxing training. Having a knockout limit would force the corner of a boxer to throw in the towel and end the fight more often as to not accumulate knockouts on their fighter's record. Thus, shortening their career.

A knockout limit would also force boxers to take on average less fights per year and fight less over the course of their career because they would be protecting themselves from any potential of being subjected to a knockout (Cantu, 1994). This might also deter boxers from

taking on an opponent who is known for being a “knockout artist” such as Deontay Wilder. A boxer might reconsider accepting a fight with a power puncher, especially late in their career if their knockout count is approaching the limit, this would also reduce the number of devastating powerful head strikes which could result in brain hemorrhaging and potentially even death.

Along the same lines as a knockout limit, a “knockdown” limit is one that can be used over the course of the fight. The same principle applies to the knockdown limit, it would be a finite number of knockdowns a boxer is legally allowed to withstand over the course of the boxing match (Cantu, 1994).

A hypothetical example of this in practice would be a knockdown limit number of three knockdowns per fight. Once a boxer falls to the canvas a third time in the fight, he is deemed too damaged by the commission's standards, and the referee will stop the fight. The concept of limiting knockouts and knockdowns in conjunction with the other proposed solutions discussed by doctors and experts, would exponentially make the sport of boxing safer for its athletes (Cantu, 1994). Each proposed rule change is done with the mindset of prioritizing fighter safety and reducing the amount of trauma the brain will undergo over the course of a boxer's career.

Conclusion

The world of combat sports is one that is widely viewed as not only a historic sport but also a violent and dangerous one. In combat sports, a contestant wins by scoring more points than their opponent, disabling their opponent, or attacking their opponent in a designated technique specific to the sport that they are competing in. The sport of boxing has been around since the times of the Ancient Greeks and became an Olympic sport in the year 688 BC. Boxing was the most popular and widely renowned form of combat sport for the entire 20th century. In the early 1990's a new form of combat sport was introduced and took the world by storm, the sport of MMA. Since its inception, MMA has become the most popular and most viewed combat sport in the world. At a first glance, when comparing these two popular combat sports, it would be easy to assume that boxing would be the safer out of the two. MMA uses techniques involving elbow strikes, kicks, chokeholds among other nontraditional methods of attack.

Even the equipment used would appear to favor boxing. Boxers use larger more padded gloves which absorb impact better than the four-ounce MMA gloves. Boxing matches also have shorter rounds which would in theory favor safety and fatigue. The nature of boxing lends itself to being a more dangerous sport in terms of head strikes. With only two surfaces to throw punches at, the head takes most of the punches thrown during a boxing match. Lack of areas to aim attacks at mixed with the punching output of a professional boxer becomes a perfect storm for concussions and other brain trauma related diseases to develop. A professional boxer on average lands around one hundred and eighty significant strikes to the head of his opponent over the course of a twelve round boxing match.

For a comparison MMA athletes will on average only land four strikes per minute or roughly sixty strikes per fight. The reason for the number of strikes being so much lower in

MMA is simply the nature of the sport. MMA is a combat sport comprised of other known and established forms of combat and defense. Most of these disciplines involve not punching but wrestling and grappling. These techniques such as Brazilian Jiu Jitsu, center around wrestling an opponent to the ground and maneuvering both yourself and your opponent in a way that can render a body part useless or choking your opponent forcing them to “tap out” and end the fight via a submission. With these types of combat disciplines, since there are no strikes from arms or legs, the brain is not undergoing high impact trauma.

When analyzing injuries and damage sustained in professional sports and Combat Sports specifically. Concussions and CTE are by far the most significant and dangerous injuries athletes can possibly withstand. Chronic traumatic encephalopathy (CTE) is a progressive brain condition that is thought to develop from repeated blows to the head and resulting in high frequencies of concussions. Taking blows to the head over the course of a fight causes the brain to repeatedly hit the inside of the skull cavity causing what is known as a concussion. With the discovery of CTE in 2002, the disease has been on the forefront of medical advancement and is the focus of every contact sport since its discovery. Chronic traumatic encephalopathy or CTE was first observed in boxing gyms in the 1920’s when boxers and doctors referred to it as “Punch Drunk Syndrome’. It was looked upon as a minor side effect and was dismissed from being viewed as a disease that could jeopardize long term brain function and athlete health by medical professionals. It was observed frequently in boxing gyms when athletes would have loss of balance, slurred speech, mood swings and headaches. CTE develops with repeat concussions, American Football and boxing are the sports with the highest concentration of CTE in athletes.

Brain degeneration associated with symptoms of CTE include memory loss, confusion, impaired judgment, impulse control problems, aggression, depression, suicidality, parkinsonism, and eventually progressive dementia and eventually lead to an early death. Experts agree that the structural design of boxing is what makes concussions and CTE skyrocket within the sport. The structure of boxing as we know it was developed in the year 1865 with a rules board known as the Marquess Queensberry Rules. Before the Queensberry Rules, boxing matches were contested under what was known as the London Prize Ring rules. One of the main differences between the two rule sets was that in the London rules, bouts were to be fought with no padded gloves. Padded gloves were introduced in 1865 when the Queensberry Rules were devised. Another major difference between the two rule sets was that in the Queensberry rules, there was to be a round system. Twelve rounds that are three minutes long with a one-minute break in between rounds. Boxing historians and doctors believe that the introduction of the Queensberry rules, and the subsequent negative properties it brought can be directly blamed for the prominent levels of CTE and why boxing is viewed as the most dangerous combat sport by doctors and medical professionals.

Something that the Queensberry rules brought was a round system. A standard sanctioned match totals thirty-six-minutes. Boxing experts and combat sports historians passionately believe that this is just simply too long for a fight to last. Over the course of a match, high volume boxers like Manny Pacquiao can throw over a thousand punches at their opponents during the thirty-six-minute bout. This hyper frequency of shots to the head is what is known to cause CTE. When athletes receive concussions and then are subjected to more head trauma whilst already having a concussion brain swelling, hemorrhaging, the development of CTE and even death can occur as a result. If a boxer withstands a flurry of punches from his opponents, multiple concussions and

hemorrhaging are likely to take place. The brain (just like any body part) can swell when it undergoes high levels of impact such as a punch.

When a boxer gets hit with a clean shot to the head, the force of the punch would snap the athletes head back and their brain compresses against the inside of the skull due to the high G forces. Once this high impact mechanism takes place, the brain begins to swell inside of the head cavity. Once your brain swells and expands, it becomes significantly easier for your brain to hit the inside of the skull cavity because the brain's increased volume takes up more room.

Experts strongly believe that boxing matches should last half of the time that they currently do so the fighters have less time to take blows to the head. Data suggests that cutting the time of boxing matches in half would directly cut the number of punches thrown in half as well which would greatly reduce the number of concussions and reduce the risk of CTE in half in return. To compare, the UFC's sanctioned fights last three rounds with each round lasting five minutes for a total of fifteen minutes. Between rounds, MMA athletes are given a one-minute break (same as boxing) to recover. With potentially only fifteen minutes of fight time, the techniques of body and leg kicks, the disciplines of wrestling, grappling, jiu jitsu and other ground related techniques such as submissions make strikes to the head (especially rapidly repeated ones) far more unlikely. The structure of MMA with the majority of techniques being non striking based makes it a much safer form of combat sport in regard to obtaining concussions and developing the brain disease known as CTE.

Experts and doctors agree that most brain related injuries when it comes to combat sports occur during training in the gym as opposed to the fight itself. MMA athletes are at an advantage when it comes to this. Mixed Martial Arts competitors are forced to divide up their training time to incorporate multiple disciplines of combat such as the previously mentioned Jiu Jitsu. Having

to spread your training time into different fighting techniques results in MMA fighters taking less head strikes in training due to striking not being the focus. Boxers (due to the nature and rules of their sport) are only able to work on striking since there is no way for a fight to make its way to the ground. One hundred percent of a boxers training camp is spent refining striking techniques and sparring other opponents. Sparring is a training technique that mimics a real fight and simulates live action combat. Even training in a controlled environment such as their team's gym, fighters are still subjected to taking blows in these simulated bouts. In boxing training camps, sparring typically exceeds the standard twelve round period for conditioning purposes. The way of thinking being, if you can perform and get used to a bout that is longer than the actual match, you will be more prepared for the shorter time and thus be more conditioned and effective in your abilities. Neurological specialists believe that these sparring sessions are what develop CTE, not the fights themselves. With the data supporting the fact that most injuries occur in training, live sparring sessions are indeed to blame for a substantial portion of these traumatic brain injuries and concussions that occur during a boxer's career.

The frequency of fights during a fighter's career parallels their training camp schedule. A training camp for a fighter in any combat sport is usually synonymous with being a twelve-week bootcamp. A professional boxer fights on average three times per year which is effectively double what a UFC rostered fighter would. Fighting three times per year and undergoing a three-month bootcamp per fight leads the average boxer to being in the gym and exchanging blows for nine months per year, twice what an MMA fighter would undergo. It is the opinion of experts and brain trauma doctors that the frequency of bouts and competition needs to be managed to prioritize the health, safety, and longevity of the fighter.

The sport of boxing is often synonymous with corruption and politics. A highly touted fighter can sign a contract to fight under a certain organization and be groomed to be the next big star early in their career. This often means that the promoted fighter will be given easier fights than someone who is not as popular. Boxing organizations “pad the stats” of their promoted fighter so that they are perceived to be potentially better than they are. Often if a boxer has more than five losses in their career they are often viewed as being out of contention of a championship and deemed to be average. Keeping the promoted fighters record as perfect as possible is what the promotion attempts to accomplish by giving the popular fighter easier less skilled opponents. This manipulation often has extremely dangerous effects on a boxer's health. With the opponent being notably less skilled, the boxer who is being pushed by the promotional company usually wins the fight easily. These lesser skilled fighters have a tough time keeping up with and defending themselves effectively against the more skilled boxer. This distinct difference in skill is incredibly unsafe and can result in the less skilled fighter being struck at exceedingly high volumes causing severe brain trauma.

The implementation of a fighters cornerman is a very important structural piece of a competitor's safety. The individuals that comprise the corner are the fighters' coaches that have been with the athlete for years. The cornermen for a fighter have a few main jobs during the duration of a bout. One of the things that a corner provides is giving their fighter tips on how to be more successful during the fight. Being that the corner is comprised of high-level coaches, they provide a separate set of eyes on what is happening during the fight and relay potential adjustments to the fighter during the fight and in between rounds. A MMA corner's primary reason for being at the fight cage-side is to give their fighter the best chance to win by telling adjustments and providing moral support to the athlete during the fight. In boxing the corner's

primary job is fighter safety with the secondary responsibility of making fight adjustments. The reason that these two cornermen's responsibilities are reversed is due to how different each sports refereeing structure is. In boxing the cornerman can choose to throw the towel in ending the fight during the round or they can choose to throw the towel into the ring in between rounds if their fighter is not responding to stimuli in a normal fashion. Cornermen are to be the adults in the room and do what is best for their athletes' health and safety. The corner and coaches' job is to be responsible and get their fighter home in one piece without taking unnecessary damage once the fighter is no longer able to win.

The structure of all sanctioned combat sports requires the use of the referee. A referee is a highly trained medical professional that stands inside the ring or octagon and provides supervision and enforces the rules of each specific sport during the fight. Not only are the established rule systems in boxing and MMA different, but so are how referees are supposed to monitor the fights and supervise them. In the sport of boxing, the referee is usually there to separate the boxers when they are engaged in a clinch. A clinch is when both boxers are very close to each other and wrap their arms around one another to minimize potential for close range shots either to the head or body. When a boxing referee sees competitors engaged in a clinch, he will step in, separate them a few feet from each other and both parties will resume from a normal boxing stance and approach. Fighter safety in boxing is often not thought about in terms of the rule set. Since the inception of the Queensberry rules, very few amendments have been made, making the rule set not become questioned.

One rule that results in unnecessary damage for a boxer is the rule of the standing ten count. The Queensberry Rules say if a boxer falls to the floor because of a punch from a lapse in consciousness, the referee will stand next to the downed athlete and audibly count to ten. If the

boxer can return to his feet within the ten second count, they can resume the match. According to experts and brain trauma doctors, this rule by itself is a major cause of boxing fatalities and neurological damage. Getting back up after exceeding the brains capabilities and taking more punches often results in severe brain damage and even death.

On average thirteen boxers per year die in the ring because of repeated brain trauma. Repeated blows in a brief period, irresponsible management from the corner with rule set in professional boxing relating to the referee's job are the reason deaths in boxing continue according to experts and doctors. The staggering number of thirteen deaths a year in the sport of boxing because of punches leading to brain trauma, boxing tops all combat sports in fatalities. The compiling nature of brain trauma injuries would be reduced if it were not for the standing ten count allowing a brain damaged fighter to get up and continue.

Most forms of combat sport use of some form of padded leather glove, usually filled with cotton, or another fiber. Gloves are designed to protect the fighters' hands. In boxing and Mixed Martial Arts, hands are used not only to punch but also block. Defending your head and body by moving your gloves in the way of the punch to deflect or absorb energy is boxing's form of defense. In Mixed Martial Arts, gloves are used in the same fashion, however they are also utilized to block and kicks as well as punches and elbow strikes. The strike force relating to the kinetic properties of boxing gloves is another factor in increased brain damage and CTE rates. When compared to a bare fist, a padded professional boxing glove reduces the impact force by forty percent. If boxers used a lighter less padded glove, matches would end a lot sooner because the less force absorbed by the gloves would transfer into the boxer who is being hit. The harder a boxer were to get hit, the less likely it is that they will be able to regain consciousness and be

able to get back to their feet before the ten-count e thus ending the fight. The shorter a fight lasts, the less time an athlete has to get hit and suffer repeated brain trauma.

To make boxing safer, changes need to be made sooner than later. Rules such as the standing ten count, which gives the damaged boxer too long to regain consciousness and continue with the fight need to be rescinded. Boxing analysts state that this rule needs amendment by either removing the ten count completely or shortening the count to five or six seconds. Another rule change that needs implementation is in regard to the referee. If a boxing referee were able to end the fight before a fighter hits the canvas (like how Mixed Martial Arts referees implement the Technical Knockout) prolonged bouts that yield extreme levels of trauma would a rare occurrence.

As the research states, it is very clear that boxing is in fact the most dangerous and hazardous combat sports out today. With the expanding knowledge of brain trauma and CTE, informing athletes and coaches about the dangers of repeated blows to the head along with fundamental rule changes prioritizing fighter safety, the sport of boxing could one day be a lot safer for its competitors. The goal of these rule changes is to eradicate the high number of concussions, brain hemorrhaging, CTE and death from the historic and world-renowned sport of boxing.

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